

Important Arbovirus Vector Mosquito Species

Known and Suspected Vectors of West Nile Virus

***Culex pipiens*:** Among the more common mosquito pests in Virginia, *Cx. pipiens* is found in urban and suburban communities as well as on rural premises. It breeds in underground storm sewer catch basins; artificial containers; gutters; polluted ground pools; bird baths; discarded tires; animal waste lagoons; farm animal wallows; clogged, grass choked ditches; in effluent from sewage treatment plants; and in other sites that are slightly to very eutrophic or polluted with organic wastes. This mosquito is a nighttime flyer that will invade houses where it will hide in corners and in dark places during the day. This mosquito feeds principally on birds, but will feed on humans, particularly when inside a house. *Cx. pipiens* over-winters as adult mosquitoes, hiding in culverts, under houses, and inside outbuildings. In the spring, eggs are laid on top of water, in suitable habitats. The eggs hatch into larvae that mature within two weeks when water temperature and nutrient levels are relatively high. *Cx. pipiens* females may travel up to 3/4 of a mile in a single night in search of a blood meal, but generally are found within 1/2 mile of their breeding habitat. *Cx. pipiens* is the most important primary vector for WNV (amplifies WNV in the bird population). *Cx. pipiens* were the most common field collected mosquito to be found carrying WNV in during 1999, 2000 and 2001. For example, in 2001 there were five times as many *Cx. pipiens* that tested positive for WNV as *Cx. restuans*; *Cx. restuans* were the second most common field collected mosquito to test positive for WNV. *Cx. pipiens* are generally not readily trapped in large numbers with CDC traps, so low numbers in a CDC trap do not necessarily indicate low numbers in the environment. Their populations are best monitored with gravid traps baited with an appropriate infusion bait. *Cx. pipiens* are found anywhere in Virginia and can be among the most abundant species in urban environments.

***Culex restuans*:** Among the more common mosquitoes in Virginia, *Cx. restuans* is found in most of the same breeding habitats as *Cx. pipiens*. *Cx. restuans* becomes active in the early spring and is the most common *Culex* species found during the springtime. *Cx. restuans* becomes slightly less common during the warm summer months when *Cx. pipiens* is most active. *Cx. restuans* is a night time biter that feeds almost exclusively on birds. Laboratory trials show them to be moderately competent WNV vectors, but they are probably the second most important primary vectors that amplify WNV in the bird population and they are among the two most common field collected mosquito species to test positive for WNV during the 1999 through 2004 seasons. *Cx. restuans* are more readily trapped with properly baited gravid traps than with CDC traps. Low numbers in a CDC trap do not necessarily indicate low numbers in the environment.

***Culex salinarius*:** This species was identified as the most likely bridge vector for human WNV cases on Staten Island, NY in 2000. It is the third most common mosquito species to test positive for WNV. *Cx. salinarius* breeds in temporary flood-pools/puddles on the margins of freshwater, brackish or saltwater marshes. It may also be found breeding in any grass choked, stagnant puddle, or in large artificial containers containing a mixture of water and grassy organic matter or other vegetation. It can be found anywhere in Virginia and can be among the most

abundant species in some areas during the summer. It is attracted to CO₂ baited CDC traps and is often caught in large numbers in coastal communities. It is rarely collected in gravid traps. *Cx. salinarius* is a nighttime flyer that may invade houses. It feeds readily on both birds and large mammals including humans. The flight range of *Cx. salinarius* is approximately 2-3 miles. It overwinters as an adult in rodent burrows, culverts or other sheltered areas, and may become active even during the winter months on days when the air temperature is high enough to allow flight (e.g., >55°F).

Culex erraticus: *Cx. erraticus* is a small dark, chocolate-brown colored mosquito with white markings on its abdomen. It breeds in semi permanent pools and along pond margins in among overhanging vegetation or willow roots. It may have a flight range of several miles and is known to take the majority of its blood meals from large mammals such as horses and livestock, but also bites birds. It has been found infected with WNV in a number of states. It can only be collected in CDC light traps and will not come to gravid traps.

Ochlerotatus triseriatus: *Oc. triseriatus* known as the “eastern tree hole mosquito” is found throughout Virginia. *Oc. triseriatus* favors laying eggs in tree holes (holes in tree trunks that hold water), but also breeds in artificial containers that are in shady locations and are polluted with some tree debris (leaves, etc.). It is often found in association with tire piles. *Oc. triseriatus* feeds during the day and its flight activity generally ends at dusk. *Oc. triseriatus* typically does not travel more than about 500 ft from its breeding habitat, so if tree hole mosquitoes are an identified problem, their breeding habitat is generally going to be close by. *Oc. triseriatus* has been identified as a moderately efficient WNV vector in the laboratory, but field data in 2000 and 2001 have shown it to be the fifth most common mosquito species found carrying WNV. *Oc. triseriatus* are not readily trapped with CDC traps, so detection of low numbers with a CDC trap may mean that there are many more in the environment.

Ochlerotatus japonicus: *Oc. japonicus* was first discovered in the United States in New York in 1998. Since that time it has been discovered throughout the states of Connecticut, New Jersey, and Pennsylvania. More recently it has spread south through central and western Maryland, Washington D.C., and all of the piedmont and mountain counties in Virginia. In 2004 it was detected in several locations within the coastal plane of southeast Virginia. *Oc. japonicus* is associated with rock pools (holes in rock outcrops that hold water), but it breeds equally well in all forms of artificial containers. It can be found sharing its breeding habitat with *Oc. triseriatus* and like that species, becomes active early in the season (late March). Little is known about *Oc. japonicus*’ flight range, or its feeding preferences, but it will bite humans. It was the sixth most common field collected mosquito to be found carrying WNV in 2001. In laboratory trials it has been shown to be a highly efficient vector of WNV. *Oc. japonicus* are not readily trapped with CDC or gravid traps, so detection of low numbers in a trap may mean that there are many more in the environment..

Aedes albopictus: *Ae. albopictus* is a container breeder that is found throughout Virginia and is easily the most common urban, suburban and rural nuisance mosquito associated with artificial breeding habitats. *Ae. albopictus* feeds during the day and its flight activity generally ends at dusk. However, it will enter homes at dusk, and once inside, will bite during the night even in darkness. *Ae. albopictus* does not become active until mid spring (late April) and is most

common during the summer months. This mosquito favors laying eggs in artificial containers that are in shady locations and are polluted with some tree debris (leaves, etc.), but it will also breed in tree holes. It is often found sharing larval habitats with *Oc. triseriatus* and *Oc. japonicus*. *Ae. albopictus* does not frequently travel more than about 500 ft from its breeding habitat, so if tiger mosquitoes are an identified problem, their breeding habitat is going to be close by. Populations of this mosquito are usually greatest around bushes and foliage nearest to the breeding habitat. *Ae. albopictus* has been identified as one of the most efficient WNV vectors in the laboratory, but due to it not normally feeding on birds, its role in field transmission is still unclear. In Virginia, it is the fifth most common mosquito found carrying WNV. *Ae. albopictus* may also be an important vector of LaCrosse Encephalitis. *Ae. albopictus* are not readily trapped with traps, so detection of low numbers with a trap may indicate that there are many more in the environment.

***Ochlerotatus atropalpus*:** *Oc. atropalpus*, known as the “rock pool mosquito” breeds mostly in rock pools (holes in rock outcrops that hold water), but have been known to occasionally breed in artificial containers, away from the rocky stream or river habitats where they are usually found. Like most other container breeding mosquito species, this mosquito feeds during daylight hours and does not venture far from its breeding habitat. They are known to bite humans and can be persistent biters near their habitat. Laboratory trials have shown *Oc. atropalpus* to have one of the highest WNV vector competencies, but due to their limited distribution (mostly in places where rock pools occur) few have been captured and tested, and none have been found carrying WNV.

***Aedes vexans*:** *Ae. vexans* is a floodwater breeder found throughout Virginia. It breeds in a great variety of temporary flood-pools, usually in woodlands or grassy sites (fields, ditches), and can be produced in large numbers in these habitats. Eggs are laid in moist depressions, especially those containing moist organic debris, and hatch when they are flooded by water. Eggs may hatch during the same season in which they were laid, or may also sit on dry ground for several seasons until stimulated to hatch by floodwater. Several generations of this mosquito can occur each year. *Ae. vexans* has a flight range of 5 miles, but is normally found in large numbers within ¼ mile of its breeding habitat. It feeds during dusk and after dark. Laboratory studies have shown it to be relatively inefficient as a WNV vector, but this mosquito can occur in large numbers and was suspected of being an important WNV bridge vector to horses and humans in New Jersey in 2000.

***Ochlerotatus sollicitans*:** *Oc. sollicitans* is a saltmarsh breeder found primarily in coastal Virginia, but may occur anywhere in the state where water habitats and salinity levels are adequate. It is a fierce, aggressive biter that can be produced in large numbers in saltmarsh habitats. *Oc. sollicitans* has a flight range of 5 to 10 miles, but may travel 40 or more miles. It takes feeding flights during dusk and after dark and is strongly attracted to lights, so it may migrate from salt marshes toward nearby towns. However, it will feed at any time during the day when its resting sites are invaded. Laboratory studies have shown it to be a moderately efficient WNV vector, but field studies have also shown that this mosquito feeds mainly on large animals and only a small proportion of its blood meals come from birds. Thus, only a very low proportion might be infected with WNV. However, this mosquito can occur in huge numbers and care should be taken to avoid excessive exposure to them.

Known and Suspected EEE Vectors

Culiseta Melanura: *Cs. melanura* is the primary vector for EEE. It breeds in underground aquatic crypts or sheltered bodies of water in among tree roots. These habitats are mostly found in white cyprus swamps or maple swamps along the coastal plain of Virginia. It has a flight range of about five miles. *Cs. melanura* is uncommon in the piedmont or mountain regions of the state. *Cs. melanura* is primarily a bird biter and it plays an important role in spreading EEE to the bird population within its endemic zones. Infected birds then carry EEE to other areas where it is picked up by bridge vectors. *Cs. melanura* can be trapped using the CDC light trap.

Coquilletidia perturbans: *Cq. perturbans*, “the cattail mosquito” breeds in cattail marshes or any marsh containing deep water with emergent reed-like vegetation. *Cq. perturbans* has a flight range of about five miles and feeds mostly at night, but will bite during the day in shady areas when its vegetated resting areas are disturbed. It is readily caught in CDC light traps and is thought to be one of the most important vectors of EEE.

Culex. Salinarius:

Aedes vexans:

Aedes albopictus:

Ochlerotatus canadensis:

Ochlerotatus sollicitans:

Known and Suspected LAC Vectors

Oc. triseriatus: This mosquito is the most important vector of LaCrosse Encephalitis.

Aedes albopictus: This mosquito is a newly identified LAC vector

Ochlerotatus japonicus: This mosquito is a newly identified LAC vector

Ochlerotatus canadensis:

Other Mosquito Species

As the transmission of WNV is new in the United States, our knowledge of its vectors here is incomplete. During the 2001 season, 24 species of mosquitoes were found in the field carrying West Nile virus; 22 of those species are found in Virginia (see Table 1 below). About a dozen species of mosquitoes have been tested in the laboratory for their WNV vector competence (ability to become infected with, and transmit WNV). Those species that occur in Virginia and have high or moderate WNV vector competence have been described above. Other

tested species have shown only low vector competence or no ability at all to become infected with and transmit WNV. Several other mosquito species in the *Ochlerotatus* genus have demonstrated potential to be WNV vectors in the laboratory and/or field. These include floodwater and salt marsh species. Thus far, the only floodwater species besides *Ae. vexans* to show potential as WNV vectors are *Oc. canadensis*, and *Oc. trivittatus*; a number of each of these mosquito species collected from the field in over the past three years in Northeastern United States, were carrying WNV. Other mosquito species that may serve as WNV vectors are likely to be discovered. Based on further surveillance information from other states and from Virginia's mosquito surveillance program, other species will be added to the known and suspected list as their vector potential is discovered.

Table 1: Field collected mosquito species found to be carrying West Nile virus (WNV) in the United States in 2001 and 2002 (carrying WNV does not necessarily mean that the mosquito was infected with, or had the ability to transmit the virus while feeding).

Rank	Total Positive Pools Found	Species	WNV Vector Competence	Vector Status *
1	1,286	<i>Culex pipiens</i>	Moderate	Primary & Bridge vector
2	346	<i>Culex restuans</i>	Moderate	Primary vector
3	141	<i>Culex salinarius</i>	High	Bridge & Primary vector
4	73	<i>Ochlerotatus triseriatus</i>	Moderate	Bridge vector
5	57	<i>Aedes vexans</i>	Low	Bridge vector
6	48	<i>Aedes albopictus</i>	High	Bridge vector
7	36	<i>Anopheles punctipennis</i>	Unknown	Bridge vector ?
8	35	<i>Ochlerotatus jap. japonicus</i>	High	Bridge vector
9	22	<i>Culiseta melanura</i>	Unknown	Primary vector ??
10	22	<i>Anopheles quadrimaculatus</i>	Unknown	Bridge vector ?
11	19	<i>Culex erraticus</i>	Unknown	Bridge vector
12	15	<i>Coquilletidia perturbans</i>	Low	Bridge vector
13	14	<i>Ochlerotatus trivittatus</i>	Unknown	Bridge vector ?
14	8	<i>Ochlerotatus sollicitans</i>	Moderate	Bridge vector
15	6	<i>Ochlerotatus taeniorhynchus</i>	Low	Bridge vector
16	6	<i>Ochlerotatus can. canadensis</i>	Unknown	Bridge vector ?
17	6	<i>Psorophora columbiae</i>	Unknown	Bridge vector ?
18	4	<i>Anopheles barberi</i>	Unknown	Bridge vector ?
19	2	<i>Aedes aegypti</i>	Moderate	Bridge vector
20	2	<i>Orthopodomyia signifera</i>	Unknown	Unknown ?
21	1	<i>Aedes cinereus</i>	Unknown	Bridge vector ?
22	1	<i>Anopheles walkeri</i>	Unknown	Bridge vector ?
23	1	<i>Culex territans</i>	Unknown	Unknown ?
24	1	<i>Culiseta inornata</i>	Unknown	Unknown ?
25	1	<i>Ochlerotatus atlanticus</i>	Unknown	Bridge vector ?
26	1	<i>Ochlerotatus cantator</i>	Unknown	Bridge vector ?
22	1	<i>Psorophora ciliata</i>	Unknown	Bridge vector ?
24	1	<i>Uranotaenia sapphirina</i>	Unknown	Unknown ?

* Primary vectors feed on birds and maintain WNV in bird population; Bridge vectors feed on numerous animal species including horses, humans and birds and serve as a bridge for the virus to move from bird to mammal.